

REMARKS

Applicants appreciate the continued thorough examination of the present application by the Examiner, and the withdrawal of all of the earlier rejections. In order to advance the application to allowance, and to narrow the issues for consideration on appeal, if necessary, independent Claims 21 and 38, and all of their dependent claims, have been canceled, so that only independent Claim 1 and its dependent claims remain. Applicants will show below that independent Claim 1 includes a combination of five (5) recitations that are not described or suggested by U.S. Patent 4,965,118 to Kodera et al., U.S. Patent 5,620,817 to Hsu et al. and/or U.S. Patent 6,410,213 to Raguin et al. Accordingly, Applicants respectfully request entry of this Amendment and allowance of the present application for the reasons that will now be described.

Independent Claim 1 Is Patentable Over Kodera et al. In View of Hsu et al. and Raguin et al.

Independent Claim 1 recites a method of fabricating an array of microlenses comprising five interrelated recitations:

- (1) scanning a radiation beam;
- (2) at varying amplitude;
- (3) through a substrate that is transparent thereto;
- (4) into a negative photoresist layer on the substrate;
- (5) to image the array of microlenses in the negative photoresist layer.

As noted in the present application, for example at Page 20, line 13-Page 21, line 12:

Additional discussion of the use of back-side imaging and/or negative photoresist according to some embodiments of the present invention now will be provided. In particular, as was described above, it may be difficult to create desired shapes for optical microstructures using standard lithographic approaches, particularly when applied to thick films of photoresist, i.e., layers of photoresist that are thicker than about 10 μ m. Issues of uniformity of the thickness of the photoresist and quality of the photoresist surface can also interfere with the process. Given its base application in integrated circuit fabrication, photolithography has conventionally been performed on substrates such as silicon or other semiconductors which generally are not transparent to the wavelengths of radiation used in the photolithographic process. Accordingly, front-side exposure is conventionally made from the air or free side of the coating of photoresist, remote from the substrate.

In contrast, some embodiments of the present invention expose photoresist through the substrate. Since some embodiments of the present invention need not be concerned with the electrical properties of the substrate that form the master, material such as plastics that are transparent to the wavelengths of radiation that are being employed, may be used. Thus, the photoresist can be exposed through the substrate. Although back-side exposure is applicable in principle to both positive and negative photoresists, it may be particularly beneficial when using negative photoresist.

When exposed through the substrate, negative photoresist can naturally form shapes with their bases adjacent the substrate. In contrast, front-side exposures generally involve some attenuation of the beam energy as it penetrates through the photoresist film. This attenuation generally provides more exposure on the top of the photoresist than at the base thereof, resulting in undercutting. With back-side exposure, there also may be attenuation, but the attenuation can be in the desired direction, with the base of the structure receiving more exposure than the top.

Using back-side exposure, the height of the feature to be formed also can be rendered independent of the thickness of the photoresist. This may be difficult with front-side exposure, since the exposure may need to proceed all the way through the photoresist, from the outer surface of the photoresist to the base thereof, in order to not be washed away. Accordingly, some embodiments of the present invention can make shapes of varying heights, and the uniformity of the thickness of the photoresist and the quality of the photoresist surface need not play a critical role in determining the quality of the optical microstructures.

Applicants will now show that the combination of Kodera et al., Hsu et al. and Raguin et al. does not describe or suggest many of the recitations of independent Claim 1.

In particular, Kodera et al. does not describe or suggest (1) scanning a radiation beam, (2) at varying amplitude as recited in Claim 1. Rather, as noted in Kodera et al. Column 6, line 21-41:

1.2 Manufacturing method

Most suitable material constituting respective components will be described while explaining a method of manufacturing the disk 100. First, as shown in FIG. 2, a resin mold 130, on which an uneven pattern 131 having an opposite relationship with respect to the uneven pattern corresponding to information to be recorded is formed, is prepared. A resin liquid 140 of the ultraviolet ray hardening type or the electron ray hardening type is painted on the resin mold 130. From the side of the resin liquid 140, ultraviolet rays or electron rays 150 are irradiated, thus to harden and give form to the resin liquid 140. The hardened resin layer serves as the resin layer 110. After this, the resin layer 110 is disconnected from the resin mold 130. When needed, ultraviolet rays or electron rays are irradiated for the second time to complete hardening of the resin. Since the resin thus hardened is subjected to three-dimensional bridging

hardening, it exhibits a high heat resistance property and high solvent resistance property. (Emphasis added.)

Accordingly, in Kodera et al., there is no need to scan a radiation beam at a varying amplitude, because Kodera et al.'s flexible optical information recording medium is patterned by molding a resin onto a substrate having a pattern on it, as shown, for example, in Kodera et al. Figures 1, 2, 4A and 4B. Rather than scanning, flooding of radiation is used to simply harden the molded resin, as noted in Kodera et al. Column 8, lines 33-43:

First, as shown in FIG. 5, the above-mentioned liquid **140** of the ultraviolet ray hardening type or electron ray hardening type is painted on the uneven surface of the resin mold **130**, and the surface of the resin liquid **140** is coated with the transparent supporting layer **210**, thereafter to irradiate ultraviolet rays or electron rays **150** while pressure-welding the supporting layer **210** and the resin mold **130** by means of a roller **220**, etc. under pressure of more than 0.1 Kg/cm², desirably more than 1 Kg/cm² according to need. (Emphasis added.)

The flooding arrows **150** of Kodera et al. Figure 2 and Figure 5 confirm that the scanning is not used and, in fact, there would be no need for scanning in Kodera et al. for the reasons described above.

At the top of Page 4, the final Official Action concedes:

The difference between the claims and Kodera is that Kodera does not disclose that the radiation beam amplitude is varied (claims 10, 27, and 42).

Applicants have shown above that Kodera et al. fails to disclose far more than varying the amplitude of radiation beam, and that the Kodera et al. does not describe or suggest (1) scanning a radiation beam (2) at varying amplitude. Moreover, Kodera et al.'s radiation does not (5) image the array of microlenses as recited in Claim 1. Rather, the radiation beam is merely used to harden the resin layer, but the array of microstructures is already formed mechanically by molding onto a patterned supporting layer.

In fact, Kodera et al. does not even appear to use photoresist, because Kodera et al.'s "resin liquid" does not appear to be capable of producing an image-wise pattern, and is not subjected to a development process. Rather, the resin liquid is simply hardened by irradiation of ultraviolet rays or electron rays, as described in the above-quoted passages of Kodera et al. Accordingly, Kodera et al. would appear to be incapable of imaging an array of microlenses, even if a radiation beam was scanned at varying amplitude.

In an attempt to supply the missing teachings, the final Official Action cites Hsu et al. However, like Kodera et al., Hsu et al. does not describe or suggest (1) scanning a radiation beam, (2) at varying amplitude, (5) to image the array of microlenses, as recited in Claim 1. Rather, in Hsu et al., a floodlight is used to expose a photoresist, but the patterning is performed using a phase shift mask, as noted at Hsu et al. Column 3, lines 14-35:

As shown in FIG. 2, a layer of negative photoresist **14** with a thickness of between about 0.5 and 3 micrometers is then formed on the first surface **51** of the transparent substrate **10** covering the patterned layer of attenuating phase shifting material **12**. Light **16** from an ultra violet flood light, having a wavelength between about 150 and 300 nanometers, is then used to illuminate the second surface **52** of the transparent substrate **10**. The light **16** passes through the transparent substrate **10** and exposes those regions of the negative photoresist **14** which are directly above the regions **22** of the transparent substrate **10** having no attenuating phase shifting material **12**. The intensity and exposure time of the light are adjusted so that the attenuating phase shifting material **12** blocks the light **16** from exposing those regions of the negative photoresist **14** which are above the regions of attenuating phase shifting material **12**. The light at the pattern edges **53** of the patterned layer of phase shifting material **12** diffuses so that the line **54** between the exposed and unexposed regions of negative photoresist is not perpendicular to the first surface **51** of the transparent substrate **10** but increasingly extends over the attenuating phase shifting material as the distance above the first surface **51** of the transparent substrate **10** increases. (Emphasis added.)

In particular, the above passage makes it clear, at the first underlined portion, that an ultra violet flood light is used, rather than scanning. Moreover, the second underlined passage above makes it clear that a phase shifting mask used to image rather than scanning a radiation beam at varying amplitude. Finally, the third underlined passage above states that intensity and exposure time of the flood light are adjusted. However, the above-quoted passage clearly does not describe or suggest (1) scanning a radiation beam, (2) at varying amplitude, (5) to image the array of microlenses, as recited in Claim 5.

The final Official Action concedes at the top of Page 4 that:

The difference between the claims and Kodera in view of Hsu is that Kodera in view of Hsu does not disclose that the optical microstructures formed are an array of microlenses and that the microstructure master is a microlens array master.

Applicants have shown above that Kodera et al. in view of Hsu et al. fails to disclose much more than this. Nonetheless, in an attempt to supply the missing teachings, the final Official Action cites Raguin et al. However, Raguin et al. clearly describes the use of positive

photoresist, and clearly illustrates at Figure 8 that imaging through the substrate does not take place. Moreover, Raguin et al. describes at Figures 8(a) and 8(b) the imaging through a mask **84.**

In summary, the final Official Action appears to make at least two erroneous interpretations of the references: in particular, neither Kodera et al. nor Hsu et al. provides scanning of a radiation beam at varying amplitude. Rather, these references both provide flooding and use mechanical molding or masking techniques to form various microstructures. Light is merely used to flood the photoresist to enable it to be hardened and cured. Any intensity variation in Hsu et al. is an adjustment of the flooding intensity, so as to control the amount of exposure. Moreover, although Raguin et al. illustrates forming an array of microlenses, Raguin et al. does not appear to provide any exposure through the substrate by scanning a radiation beam at varying amplitudes through a substrate into a negative photoresist layer on the substrate.

In conclusion, Applicants have discovered a unique method of fabricating an array of microlenses that comprises:

- (1) scanning a radiation beam;
- (2) at varying amplitude;
- (3) through a substrate that is transparent thereto;
- (4) into a negative photoresist layer on the substrate;
- (5) to image the array of microlenses in the negative photoresist layer.

The claimed invention can provide unique advantages, as was described, for example, in the above-quoted portions of the specification. The rejection appears to misinterpret Kodera et al. and Hsu et al., and appears to selectively pick and choose various features from different patents in an unsuccessful attempt to reconstruct the claimed invention. For at least these reasons, Applicants respectfully request withdrawal of the rejection of independent Claim 1.

Many of the Dependent Claims are Separately Patentable

The dependent claims are patentable at least per the patentability of the independent claims from which they depend. Moreover, many of the dependent claims are separately patentable.

For example, Claim 3 recites the fabrication of a buried array of microstructures in the negative photoresist layer. In sharp contrast, Hsu et al. does not describe or suggest forming

a buried structure because, as shown in Figure 2 of Hsu et al., the light 54 extends all the way through the layer of photoresist 14 and the final structure of Hsu et al. Figures 3 and 4 clearly show photoresist pedestals 15 that are not buried. Similarly, in Kodera et al., the features are also not buried in the photoresist layer. Accordingly, these claims are separately patentable. Similar analysis applies to dependent Claims 4-6.

Dependent Claim 8 recites rotating a cylindrical platform while simultaneously axially rastering a radiation beam at varying amplitude. Even if the rollers 220 of Kodera et al. are considered a cylindrical platform, axially rastering across a layer that is on the cylindrical platform is clearly not described or suggested. Rather, as shown in Kodera et al. at Figure 5, the radiation 150 is flooded between the rollers 220. Accordingly, Claim 8 is independently patentable.

Moreover, Claim 9 recites simultaneous translating the cylindrical platform and/or radiation beam axially. Respectfully, the cited references do not appear to describe, illustrate or suggest any such axial translation.

Claim 10 recites continuously varying the amplitude of the radiation beam. Such continuous variation is not described or suggested in Kodera et al. Moreover, Hsu et al. Column 3, lines 15-35 merely describes that the flood light intensity and exposure time may be adjusted, but does not describe or suggest continuously varying amplitude during scanning, as recited in Claim 10.

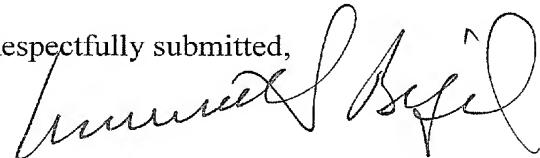
Finally, Claims 11, 12 and 13 recite the fabrication of large microlens arrays that are at least one square foot in area (Claim 11) that are scanned for at least about an hour (Claim 12) and/or that contain at least one million microlenses (Claim 13). The fabrication of these large-scale microlens arrays is not described or suggested in any of the cited references. In particular, the cited fourth reference Adler (U.S. Patent 4,087,300) describes a process for producing a metal plastic laminate that is used, for example, in fabricating metal-clad printed circuit boards. There is no description or suggestion of fabricating large-scale microlens arrays. Moreover, the Georger, Jr. et al. fifth reference (U.S. Patent 5,342,737) describes the formation of high aspect ratio metal microstructures and does not apply to the production of microlens arrays. The present application describes in detail, in the Background of the Invention section, scaling problems that may be encountered in attempting to fabricate large arrays and only the present application appears to be able to solve these scaling problems. Accordingly, these claims are also independently patentable.

Conclusion

Most of the independent and dependent claims have been canceled to advance prosecution. Applicants have now shown that the unique combination of five (5) different recitations for fabricating an array of microlenses of independent Claim 1 is not described or suggested by the combination of three references, when these references are interpreted properly. Moreover, many of the dependent claims are separately patentable. Accordingly, Applicants respectfully request entry of the present Amendment, withdrawal of the outstanding rejections and allowance of the present application.

If, in the opinion of the Examiner, a telephonic conference would expedite the examination of this matter, the Examiner is invited to call the undersigned attorney at (919) 854-1400.

Respectfully submitted,



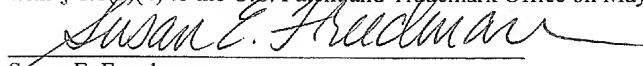
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